

CLAIMS

1. A lens-attached light-emitting element comprising:
a light-emitting element having a light-emitting area on a semiconductor substrate;
5 an antireflection film covering the light-emitting area; and
a lens formed on the surface of the antireflection film on the light-emitting element.
2. The lens-attached light-emitting element according to claim 1, wherein
10 the lens is a composite lens consisting of adjacently arranged plural parts of spherical lens, each center of the spherical lenses being on the line imagined by fastening the positions where light intensity is maximum in the light-emission area, or on the positions neighbored to the line,
15 a composite lens consisting of adjacently arranged plural parts of cylindrical lens, each cylindrical lens having an axis along the line, or
a composite lens consisting of adjacently arranged plural parts of spherical lens and plural parts of cylindrical lens.
3. The lens-attached light-emitting element according to claim 20 2, wherein
the line is an approximately U-shaped polygonal line consisting of three segments, and
the composite lens is composed of four parts of spherical lens, each center of the spherical lenses being on the both ends of each
25 segment or the neighborhood of the both ends, and three parts of cylindrical lens each having an axis parallel with the segment, the four parts of spherical lens and three parts of cylindrical lens being adjacently arranged.
4. The lens-attached light-emitting element according to claim 30 2, wherein
the line is an approximately U-shaped polygonal line consisting of three segments, and
the composite lens is composed of adjacently arranged three parts

of spherical lens, each center of the spherical lenses being on the neighborhood of the intermediate position of each segment.

5 5. The lens-attached light-emitting element according to claim 2, 3 or 4, wherein the composite lens is made of resin.

 6. The lens-attached light-emitting element according to claim 5, wherein the antireflection film is one-layer film, and the refractive index thereof has an intermediate value between that of the light-emitting area and that of the resin forming the composite lens.

10 7. The lens-attached light-emitting element according to claim 6, wherein the antireflection film consists of silicon nitride.

 8. A lens-attached light-emitting element comprising:
 a light-emitting element having a light-emitting area; and
 a composite lens provided on the light-emitting element;
 wherein the composite lens consists of adjacently arranged plural
15 parts of spherical lens, each center of the spherical lenses being on the line imagined by fastening the positions where light intensity is maximum in the light-emission area, or on the positions neighbored to the line,

 a composite lens consisting of adjacently arranged plural parts of
20 cylindrical lens, each cylindrical lens having an axis along the line,
 or a composite lens consisting of adjacently arranged plural parts of spherical lens and plural parts of cylindrical lens.

 9. The lens-attached light-emitting element according to claim 8, wherein

25 the line is an approximately U-shaped polygonal line consisting of three segments, and

 the composite lens is composed of four parts of spherical lens, each center of the spherical lenses being on the both ends of each segment or the neighborhood of the both ends, and three parts of
30 cylindrical lens each having an axis parallel with the segment, the four parts of spherical lens and three parts of cylindrical lens being adjacently arranged.

10. The lens-attached light-emitting element according to claim 8, wherein

the line is an approximately U-shaped polygonal line consisting of three segments, and

5 the composite lens is composed of adjacently arranged three parts of spherical lens, each center of the spherical lenses being on the neighborhood of the intermediate position of each segment.

11. The lens-attached light-emitting element according to claim 8, 9 or 10, wherein the composite lens is made of resin.

10 12. A lens-attached light-emitting element array, comprising a plurality of lens-attached light-emitting elements arranged in a straight line, the lens-attached light-emitting element being recited in claim 1 or 8.

13. The lens-attached light-emitting element array according to 15 claim 12, wherein the light-emitting element is a light-emitting diode.

14. The lens-attached light-emitting element array according to claim 12, wherein the light-emitting element is a light-emitting thyristor.

15. A self-scanning light-emitting element array, comprising a 20 lens-attached light-emitting element array recited in claim 14.

16. A method for manufacturing a lens-attached light-emitting element, comprising the steps of:

- (a) preparing a light-emitting element array substrate;
- (b) preparing a glass substrate;
- 25 (c) forming a etching stopper film on the glass substrate;
- (d) forming an opening array in the etching stopper film;
- (e) forming a recess array in the glass substrate under the opening array by wet etching;
- (f) fabricating a mold by removing the etching stopper film on the 30 recess array;
- (g) coating a photo-curing resin on the surface of at least one of the recess array of the mold and the light-emitting element array substrate;

(h) contacting the mold and the light-emitting element array substrate to each other with sandwiching the photo-curing resin therebetween and pressing to each other to develop the photo-curing resin therebetween;

5 (i) irradiating light to the photo-curing resin from the side of the mold to cure the photo-curing resin at the portion where the etching stopper film is previously removed;

 (j) separating the mold from the light-emitting element array substrate; and

10 (k) removing the uncured photo-curing resin on the light-emitting element array substrate by cleaning.

17. A method for manufacturing a lens-attached light-emitting element, comprising the steps of:

 (a) preparing a light-emitting element array substrate, the
15 predetermined portion thereof being masked by a tape;

 (b) preparing a glass substrate;

 (c) forming an etching stopper film on the glass substrate;

 (d) forming an opening array in the etching stopper film;

 (e) forming a recess array in the glass substrate under the opening
20 array by wet etching;

 (f) fabricating a mold by removing the etching stopper film on the recess array;

 (g) coating a photo-curing resin on the surface of at least one of the recess array of the mold and the light-emitting element array
25 substrate;

 (h) contacting the mold and the light-emitting element array substrate to each other with sandwiching the photo-curing resin therebetween and pressing to each other to develop the photo-curing resin therebetween;

30 (i) irradiating light to the photo-curing resin from the side of the mold to cure the photo-curing resin;

 (j) separating the mold from the light-emitting element array substrate; and

(k) peeling off the tape from the light-emitting element array substrate to remove the uncured photo-curing resin on the tape.

18. The method for manufacturing a lens-attached light-emitting element according to claim 17, wherein the predetermined portion is a portion including a bonding pad.

19. The method for manufacturing a lens-attached light-emitting element according to claim 17, wherein the tape is a both-side adhesive resin tape, on both side thereof an adhesion being provided, an adhesion on one side thereof losing its adhesiveness when light is irradiated.

20. The method for manufacturing a lens-attached light-emitting element according to claim 17, 18 or 19, wherein

the step (a) including,

preparing a second glass substrate,

15 drawing a masking pattern on the surface of the second glass substrate,

pasting the both-side adhesive tape to one surface of the second glass substrate,

20 cutting out the both-side adhesive tape along the masking pattern to remove unnecessary portion not to be used as a mask,

pasting the second glass substrate to the light-emitting element array substrate with the both-side adhesive tape being opposed thereto,

25 losing the adhesiveness between the second glass substrate and the both-side adhesive tape by irradiating light from the side of the second glass substrate to remove the second glass substrate.

21. The method for manufacturing a lens-attached light-emitting element according to any one of claims 16-20, wherein the shape of each opening of the opening array is approximate U-shape.

22. The method for manufacturing a lens-attached light-emitting element according to any one of claims 16-20, wherein each opening of the opening array consists of three micro circular openings which are located at the vertexes of a triangle.

23. The method for manufacturing a lens-attached light-emitting element according to claim 16, further comprising the step of coating a mold releasing agent on the surface of the recess array after the step (f).

5 24. The method for manufacturing a lens-attached light-emitting element according to claim 16, wherein the step (i) includes the step of making ultra violet or visible light to approximately collimated light and irradiating the collimated light approximately perpendicular to the glass substrate.

10 25. The method for manufacturing a lens-attached light-emitting element according to claim 16, wherein the etching stopper film is a Cr film, and the glass substrate is wet etched by a hydrofluoric acid based etchant.

15 26. The method for manufacturing a lens-attached light-emitting element according to claim 16, further comprising the step of cutting the light-emitting element array substrate after the step (k).

20 27. The method for manufacturing a lens-attached light-emitting element according to claim 17, further comprising the step of coating a mold releasing agent on the surface of the recess array after the step (f).

25 28. The method for manufacturing a lens-attached light-emitting element according to claim 17, wherein the step (i) includes the step of making ultra violet or visible light to approximately collimated light and irradiating the collimated light approximately perpendicular to the glass substrate.

29. The method for manufacturing a lens-attached light-emitting element according to claim 17, wherein the etching stopper film is a Cr film, and the glass substrate is wet etched by a hydrofluoric acid based etchant.

30 30. The method for manufacturing a lens-attached light-emitting element according to claim 17, further comprising the step of cutting the light-emitting element array substrate after the step (k).

31. The method for manufacturing a lens-attached light-emitting element according to claim 16 or 17, wherein the light-emitting element array substrate is a light-emitting diode array substrate.

32. The method for manufacturing a lens-attached light-emitting
5 element according to claim 16 or 17, wherein the light-emitting element array substrate is a light-emitting thyristor array substrate.

33. The method for manufacturing a lens-attached light-emitting element according to claim 16 or 17, wherein the light-emitting element array substrate is a self-scanning light-emitting element array
10 substrate.

34. The method for manufacturing a lens-attached light-emitting element according to claim 16 or 17, wherein the light-emitting element array substrate includes an antireflection film covering the light-emitting area of each light-emitting element.

15 35. The method for manufacturing a lens-attached light-emitting element according to claim 16, wherein

the lens is a composite lens consisting of adjacently arranged plural parts of spherical lens, each center of the spherical lenses being on the line imagined by fastening the positions where light intensity is maximum in the light-emission area, or on the positions neighbored to
20 the line,

a composite lens consisting of adjacently arranged plural parts of cylindrical lens, each cylindrical lens having an axis along the line, or

a composite lens consisting of adjacently arranged plural parts of
25 spherical lens and plural parts of cylindrical lens.

36. The method for manufacturing a lens-attached light-emitting element according to claim 17, wherein

the line is an approximately U-shaped polygonal line consisting of three segments, and

30 the composite lens is composed of four parts of spherical lens, each center of the spherical lenses being on the both ends of each segment or the neighborhood of the both ends, and three parts of cylindrical lens each having an axis parallel with the segment, the four

parts of spherical lens and three parts of cylindrical lens being adjacently arranged.

37. The method for manufacturing a lens-attached light-emitting element according to claim 16 or 17, wherein

5 the line is an approximately U-shaped polygonal line consisting of three segments, and

 the composite lens is composed of adjacently arranged three parts of spherical lens, each center of the spherical lenses being on the neighborhood of the intermediate position of each segment.

10